RTX Autonomous Vehicle Competition

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SkyTerra: Elevate, Navigate, Hydrate

Challenge Overview

The RTX Autonomous Vehicle Competition is an annual engineering challenge that requires each team to design both an unmanned ground (UGV) and air vehicle (UAV). A single team's UAV will need to seek, identify, and deliver a water blast to all rival schools' UGVs while avoiding their own.

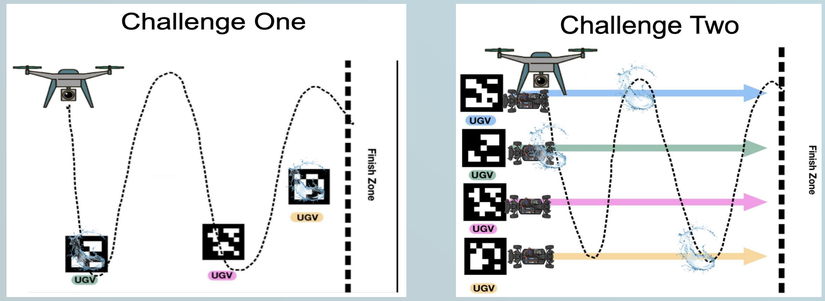

Figure 1: Diagram of Challenge 1 and 2 of the competition.

The UGV needs to:
- detect 20mL of water
- display our ArUco marker
- autonomously follow paths within ± 1 ft.

The UAV needs to:
- deliver > 20 mL of water
- detect ArUco Markers
- fly for 10 minutes
- have a pilot Kill Switch

Autonomous Mobility

Both the UGV and UAV will run autonomous missions with a Pixhawk flight controller running ArduPilot in combination with an RTK GPS system. The UGV will complete its waypoint missions using ArduPilot's built-in Mission Planner, while the UAV will be controlled with the MAVSDK library from a Raspberry Pi.

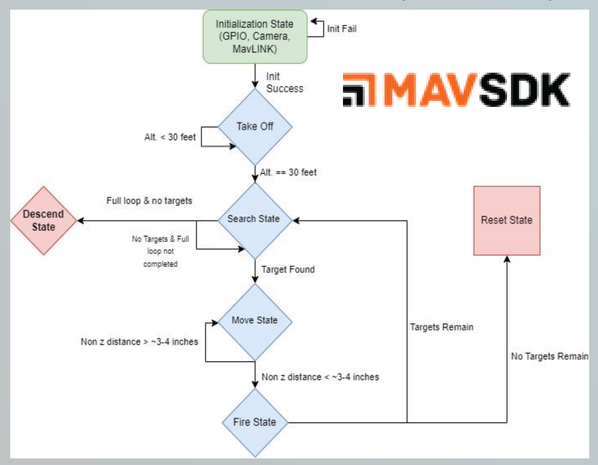

Figure 2: State machine diagram for the UAV.

UAV (Aerial Vehicle)

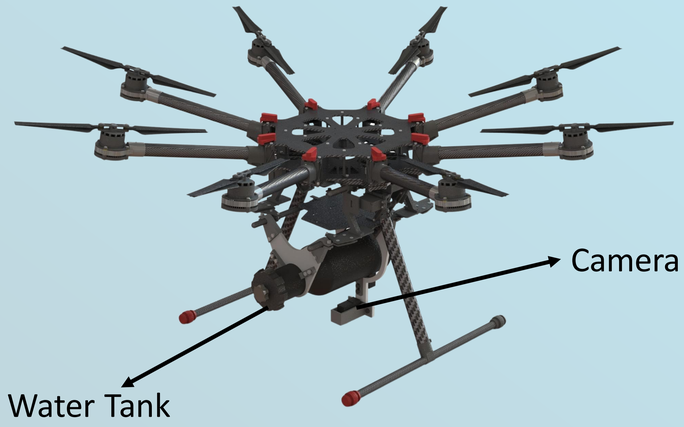

Figure 3: Final design of the UAV.

UAV Key Components

1. Water Delivery

This system uses a 64 oz water tank pressurized with 16g CO_2 canisters that fires water through custom plumbing which flows through a solenoid valve. It is able to generate a steady stream of water downwards with a flow rate of 32.8 ml/sec when activated by the GPIO output pins of the Raspberry Pi.

2. Object Detection

UGVs will be identified by their ArUco markers, using a camera attached to a Raspberry Pi running Open CV. In the library, the marker detection function scans the video feed for any markers that fit its parameters, and returns the pixel location and marker ID. The pose estimation function takes in a pre-calculated distortion coefficient matrix and your marker size; this function returns a vector with the distance from your camera to the marker.

Figure 4: ArUco markers and pose estimation.

UGV (Ground Vehicle)

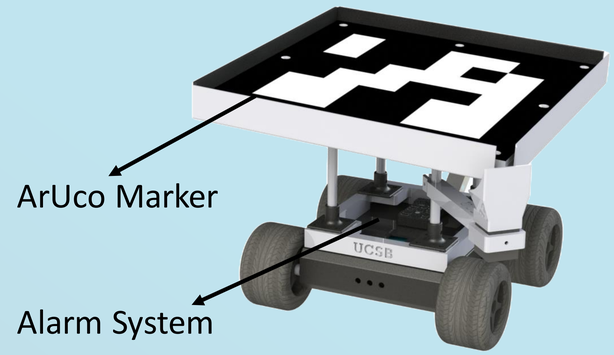

Figure 5: Final design of the UGV.

UGV Key Components

1. Water Detection:

When water is dropped, it will hit the marker, which is set at a 5° angle and coated with a hydrophobic layer. The water will then be channeled into a 3D-printed cup that contains an off-the-shelf water sensor, which then triggers the alarm subsystem.

2. Audio & Visual Cues:

When > 20 mL of water is detected, LED lights will flash and a motorcycle horn (100 dB) will sound. The motorcycle horn is necessary, given how loud UAVs are. This is our alarm system.

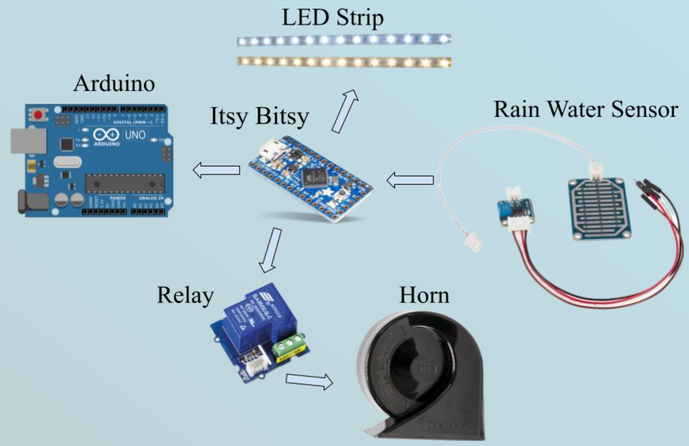

Figure 6: Connection diagram for the UGV.

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